REPORT

OF THE

Operations

of the

Arizona School of Mines

for the

Year 1896

WM. P. BLAKE, Director.

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TUCSON, ARIZONA, January 12, 1897.

TO PROFESSOR HOWARD BILLMAN,
President of the University and of the Board of Regents.

SIR :—I have the honor to submit my Report of the work of the School of Mines of Arizona for the year 1896.

Respectfully yours,
(Signed) WM. P. BLAKE,
Director.

REPORT.

The work of the School of Mines may be conveniently considered under six chief headings or divisions:

I. Instruction.
II. Investigation.
III. Testing and Assaying.
IV. Mill work and metallurgy.
V. Correspondence.
VI. Museum.

I. INSTRUCTION.

The preparation of a scheme of studies in proper sequence for the best educational results, in other words, a fixed and regular course of study, or curriculum, for the students of mining and metallurgy, especially for those wishing a full four years' course of study, early engaged the attention of the Director. This curriculum was adopted by

the University and was announced in the Annual Register for 1895 and 1896.

In the preparation of this curriculum it was sought to economize the teaching force of the University by making the course of study for the first two years as nearly parallel as possible to the course adopted for the first two years of the course of study in the department of engineering. Conformity to this curriculum is required of the students who intend to give the required four years of time to their studies and to take the degree of Bachelor of Science. Such students are classed as regular, while those who elect to take a few studies only out of the regular course are classed as irregular, or special. The greater number fall under the last designation. And most of such special students seek instruction in assaying and mineralogy, as leading them into occupations most likely to be remunerative, and as enabling them to form a better estimate or judgment for themselves of the value of many ores and mining prospects which are offered on every side on the mountain ranges of Arizona.

It thus becomes difficult to organize regular classes for instruction by lectures, for the students come with very diverse qualifications and degrees of preparation. It is necessary to give instruction adapted to each individual case. This is accomplished in laboratory work without great difficulty, but requires the constant presence and attention of the instructors.

At the beginning of the year students who had been pursuing their studies at the University for several years needed instruction in geology and mineralogy.

A class was therefore formed of such regular students together with some of the older and more advanced special students and a course of lectures on geology was given in the second and third terms. This was supplemented by laboratory instruction. The need of a collection of typical rock specimens being felt alike by the professor and students, this want was supplied by the importation of a

series of authentically labelled specimens from various foreign localities. Specimens of the rocks of Arizona were also collected at every opportunity by the Director and students until we now have sufficient material to illustrate lectures on rocks.

Special mention should be made of a well-trimmed series of about one hundred specimens of rocks to illustrate the rock formation of the Oro Blanco mining district, Arizona, collected with care and presented to the University by E. E. Noon, one of the students of geology and a resident of Oro Blanco.

A class was also organized in mineralogy and a series of lectures was given by Professor Meade Goodloe upon this subject illustrated by a series of type specimens showing color, luster and other physical characters of the common minerals.

In addition to the lectures and recitations the students were drilled in the determination of minerals and the use of the blowpipe and regents. The more common and simple chemical tests were also made in connection with this instruction and in the Assay Laboratory while the students able to give more time to the science of chemistry were instructed by Professor Forbes in the Chemical Laboratory.

Instruction in assaying extends throughout the year, in each term, and is eagerly sought by most of the students of mining whether fully prepared or not. The instruction, which of necessity is mostly practical and experimental for beginners, consists of furnace work, the preparation of mixtures, roasting, scorifying, melting and cupelling and is carried on in the Assay Laboratory while the theory of the operations is explained in the class-room and in the furnace room.

This instruction, while independent of, is yet clearly connected with the commercial assay work of the School of Mines, for as samples are received the more advanced students have the opportunity of noting the nature of various samples and the methods and processes used for

their most complete and perfect determination. It is also educational in respect of showing the geographical distribution of ores in the Territory and in making known the nature and value of the newest and latest discoveries of valuable ores. The students are thus familiarized with the appearance of ores as dug from the ground from the surface down. The commercial assay work thus becomes a series of object lessons in addition to the routine work of assaying substances and mixtures of known composition or value.

The same observations apply to the instruction in determinative mineralogy which is largely supplemented by the constant arrival of specimens of doubtful or unknown composition which receive the most careful testing by the instructors and often require also chemical operations not usually made in assay laboratories.

The instruction in milling and treating ores on a commercial scale has been given at intervals through the year, by running the mill on custom ores, or on ores specially procured for the purpose. Each lot of ore, so treated, requires the operations of sampling and assaying, not alone of the battery samples but of the tailings, and in these various operations the students have taken part and have thus been made acquainted with all the practical operations of a mill.

At the close of the summer term Professor Meade Goodloe resigned his chair to accept a position at the Congress Mine, at Congress, Yavapai County. The vacancy was filled by the selection of Mr. Chas. E. Van Barneveld, a graduate of McGill University, who has since given, together with the Director, the instruction in mineralogy and assaying.

Mr. Noon, also an advanced student in assaying who had rendered valuable service as Second Assistant in the department of assaying and in the experiments upon the treatment of ores by cyanide, resigned in the winter term to fill a more lucrative position at Oro Blanco and has since been called into the service of the Congress Company, at Congress.

The subject covered by the instruction given may be summarized as follows:

Assaying:
- Dry—furnace work.
- Wet—by chemical or moist methods.

Blowpipe practice.

Chemistry, incidental to Assaying.

Geology:
- General.
- Economic.

Mineralogy:
- Systematic.
- Crystallography.
- Determinative.

Mettallurgy:
- Sampling.
- Mill practice.
- Cyanide process.

Petrology.

II. INVESTIGATION.

In this department of work it has been found much easier to project work than to accomplish it while subject to the hourly interruptions of the routine work of instruction and correspondence. But some progress has been made in the investigation of the geologic conditions of the mountain ranges near Tucson, especially of the Santa Ritas and of the vicinity of Arivaca and Babioquivari, and of the Rincon.

The fundamental, or primal rock of the Catalinas, and of the Rincon is an ancient mica slate or gneiss to

which I have given the name *Arizonian*. It is pre-Cambrian; possibly, Huronian, possibly Archaean, but is remarkably tabular in its structure and but little uplifted though penetrated throughout by thin layers, or thick tabular inflows of granite. It offers most excellent tabular manes for constructive purposes, but is for the present too far removed from cheap transportation to be much used.

The nature and qualities of the stone used for construction of the Dormitory were thoroughly examined and formed the subject of a report to the Board. The rock is a thoroughly consolidated volcanic tufa consisting chiefly of conminuted granite held together by a siliceous cement and including fragments of slate and other rocks.

Experiments upon the so-called "Caleche" of the Tucson Mesa show that it is well adapted to burning for caustic lime. It is somewhat contaminated by included pebbles of granite and coarse granite sand, but after slaking these impurities can be screened out. When well-burned it slakes freely with water, with evolution of heat, as with other good caustic lime, and will make a strong quick-setting white mortar.

Tests have also been made of some supposedly good materials for cements. In one case the materials used contained a large amount of gypsum, vitiating them for cement work.

A trip into the northern portion of the Santa Rita range made known the existence there of an extensive deposit of stratified gypsum which might be utilized for agriculture or for making Plaster of Paris. Another deposit has been found in the Sienitas range nearer Tucson, and a furnace for burning it has been erected in Tucson, the product being used in plastering portions of the interior of the new Cathedrial.

Deposits of Wolframite, a mineral containing tungsten, have been made known to exist in the Arivaca mining district, and if the quanity is sufficient this mineral may

add somewhat to the useful mineral products of the Territory.

The work of compiling a list of the principal minerals of the Territory of Arizona has received some attention from the Director, and this list may, at some future day, be the basis of a report to the Legislature.

Several meteoric masses have been brought to the attention of the Director and have received preliminary examinations showing the presence of nickel. A lecture on the subject of meteorites was given to several of the classes together, and it was also given to an audience in Tucson.

The experimental work upon the cyanide process and its adaptation to the ores of Arizona (elsewhere specially considered) has also formed a branch of the work of investigation and is in progress.

III. TESTING AND ASSAYING.

In order to promote knowledge of the varied resources of the Territory and to meet the demand from many of the prospectors and citizens for information regarding the nature and value of many of the obscure and little known minerals, the School of Mines invites and receives such minerals, and examines them without charge. These tests are known as "qualitative" in distinction from the assays or quantitative tests by which not only the nature but the quantity of a substance is made known. The examinations are usually made by both chemical and mineralogical tests, and the results are carefully recorded and reported. The register kept of such tests shows over two hundred and fifty entries during the year, or from No. 484 to No. 734, each entry covering from one to ten or more

separate tests. The quantitative assays made are included in this number.

The correspondence connected with gratuitous qualitative work is considerable. Specimens arrive from all parts of the Territory, and some from remote parts of the country. The system is not without advantages to the School. It gives a constant supply of material for testing and occasionally a rare and interesting mineral is found. The geographical distribution of minerals, or their localities, is made better known.

The Assay Laboratory accomplished much more work in 1896 than in 1895; the receipts for the year 1896 being $368.51, against $71.05 in 1895.

IV. MILL WORK AND METALLURGY.

The demand for mill tests is increasing as the facilities offered by the School are made better known. For small lots of from 500 pounds to 2,000 pounds the small or three stamp mill is used while for larger lots the five stamp mill is best adapted.

Several lots of ore, of 100 to 300 pounds each, have also been sampled so as to get a better and general average for assay.

A great need of this department is floor covering of steel plates, upon which to spread and quarter down the samples.

As there is no fund upon which to draw for the expenses of running the mill it has been necessary to depend upon custom work. This has been sufficient for the greater part of the time or sufficient to give all the students an opportunity to see the mill in operation two or three times in each term. Two runs were made upon a lot of gold quartz presented to the School conditioned upon

paying the costs of hauling. The bullion obtained more than covered this and other expenses connected with the work, besides leaving a stock of tailings suitable for experimenting on with the new cyanide process.

This cyanide process has also engaged the attention of the School, and many laboratory tests on a small scale have been successfully made. The extraction has been carried to a high degree and the results generally have been so encouraging with many of the Arizona gold ores as to justify the belief that the process will in the near future become generally used. Preparations are making for a small experimental plant at the mill of the School large enough to give practical working tests on lots of ore from twenty-five pounds to a ton or more, and thus to give a practical demonstration of its adaptation to the ores of the Territory. Several young men have applied for special instruction in this and related branches of ore treatment.

The need of some money to erect a roasting furnace and to put up chlorination and leaching works is much felt. We should be able to demonstrate in the commercial way all of the most important metallurgical operations.

V. CORRESPONDENCE.

The correspondence of the School is voluminous. Enquiries are received by post from all parts of the United States seeking information regarding the School, its courses of instruction, special studies and requirements.

Enigmatical ores and minerals of doubtful or obscure composition are also sent in from all parts of the country and full explanations by mail are desired and are given. There are also many letters received by the Director asking for information regarding the resources of the Terri-

tory, and especially for reports or statements regarding its geology and mineralogy; for lists of its mills in operation and of any and all metallurgical works. The need of a succinct and reliable description of the mines and ore deposits of the Territory, its formations, mineral veins, product of the metals, etc., is generally deplored. It is hoped that this need may be to a great extent supplied and that with some assistance the Mining School may become a central point of reference for such information and for the mineral and mining statistics of Arizona.

In conjunction with the Director of the School of Mines of New Mexico, Professor W. H. Leamon, and the friends of mining schools generally, there has been some correspondence seeking to obtain from Congress legislation in favor of mining education equivalent to that now favoring schools of agriculture. It is urged that with a mineral production of six hundred millions of dollars in value annually, a large part of which is drawn from the undeveloped wealth of the territories and the greater need of science instauction in mining and metallurgy the people generally should favor the support of schools of mining as they now favor those of agriculture.

VI. MUSEUM.

The collection of ores, rocks, minerals and fossils which at the beginning of the year were somewhat irregularly distributed in different rooms of the building, have, since the completion of the Dormitory, been placed together in the large room in the Mining School building formerly occupied in part by the library.

There have been many accessions to the line of minerals, ores and rocks during the year. Each accession

has been numbered by the Director with the serial number of the general register and temporary labels have been written, but much work is required to label all the specimens and to properly classify them.

Amongst the chief accessions the magnificent suite of crystalline specimens from the Copper Queen Mine, at Bisbee should be mentioned. The School is indebted for them to the generosity of the Copper Queen Company by Mr. Jas. Douglas, the General Manager.

The collections of the University have also been enriched for purposes of illustration by the acquisition of a remarkably fine Arizona meteorite weighing eighty-six pounds which was found on the top of Weaver Mountain in Yavapai County. This is a holosiderite of compact and even grain and of very high specific gravity. It is malleable and exceedingly tough. It is very fortunate that at least one of the great meteorites of Arizona has been secured and held in the Territory for the instruction and benefit of the citizens young and old.

The collection of rocks from Oro Blanco District made by Mr. E. E. Noon has already been mentioned.

The collections of ores and rocks and geological specmens is growing fast and requires much care and time in classifying, recording and labelling. The specimens received by exchange at the Chicago Exposition are largely without any label, except numbers, and require identification and labelling.

The collection, with care and attention, will soon become a valuable one for reference and comparison and as illustrating the mineral products of Arizona.

A small but very interesting suite of specimens from the tombs of Egypt was presented by Mr. L. Fischer one of the students of assaying and mineralogy.

A collection to illustrate the bitumen and petroleum products of Los Angeles, collected there b Professor Goodloe has been placed in the cases of the Museum.

CONCLUSION.

The year has been marked by greater activity than before in the history of the School; a greater and increasing number of earnest students; by more work in assaying; by the experiments upon the cyanide process; by several mill runs and by considerable accession to the Museum. Enquiries come by mail from all parts of the United States. Enigmatical ores and minerals are sent in also from all parts of the country and receive careful attention. The School may thus be regarded as benefitting directly all sections of the land while special attention is given to the needs of Arizona.

In the department of instruction great and additional service would be given if a first-class stereoptican with proper fixtures could be obtained. Such an instrument is needed by every chair in the University.

A good general collection of crystalline minerals is also a desideratum.

For geological field-work several instruments are needed but more especially a direct action, positive motion nameter for measuring distances, two good Canella aneroid barometers, and a supply of draughting paper and blue print paper.

In the assay laboratory we need a melting furnace and in fact a reconstruction of or another furnace room where more light can enter and where larger muffle furnaces can be put up.

In the mill a good tight smooth sampling floor of steel plates is necessary.

With great respect,

Yours Obediently,

(Signed.) WM. P. BLAKE,
Director.